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SYNTACTIC COMPLEXITY AND THE RECALL OF SEMANTIC INFORMATION[1]

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3 groups of 20 subjects received 2 exposures of a list of 10 sentences followed by an immediate written recall test. The sentences varied in syntactic complexity from group to group, but the sentences for the 3 groups were similar in semantic content. The effect of sentence complexity upon recall performance was not found to be significant, and it was concluded that when a subject has only a single type of syntactic information to store in learning a list of sentences, syntactic complexity does not contribute to recall.

The sentences The man hit the boy, The boy was hit by the man, and It was the boy the man hit, reveal a fundamental characteristic of language, namely, that a given bit of semantic information may be embedded in a variety of syntactic contexts without being modified significantly. A "deep-structure," grammatical analysis of these sentences will reveal that each contains, among other things, a sentential structure in which man is marked as subject, hit as main verb (past tense) and boy as direct object. The three sentences differ, however, in the amount or complexity of syntactic information that must be recovered by a language user in order to process them. The semantic information in question is most directly presented in the sentence The man hit the boy. In the second sentence, however, the semantic information is presented in the context of a passive transformation, while in the third sentence, it is presented in a context that includes syntactic information relevant to two underlying strings (It was the boy and The man hit the boy), and a relative transformation that involves an embedded relative clause (The boy whom the man hit) with the relative pronoun whom deleted. In addition, Sentences 2 and 3 are longer than Sentence 1.

The foregoing considerations have some interesting implications for the problem of verbal learning, one of which is that in memorizing a sentence, an *S* will have to store both semantic and syntactic information in order to retrieve it correctly, and another, that sentence retrieval will be a function of the amount or complexity of syntactic information that accompanies a given bit of semantic information within a sentence.

With respect to the latter implication, it is reasonable to assume that syntactic complexity will affect the processing of semantic information either

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in terms of the ease with which one can "dig out" the semantic information from its syntactic context, or in terms of the amount of syntactic information that has to be processed along with the semantic information.

While it is intuitively obvious that the sentences cited above differ in syntactic complexity, it is not possible, unfortunately, at this stage in the development of linguistic theory and psycholinguistic research to formulate a rigorous definition of the notion syntactic complexity, either in descriptive terms or in terms of psychological performance processes. Some measures that have been suggested are length, number of transformations, linguistic depth, number of embedded sentences (in the case of strings that contain two or more underlying sentences), type of embedding, frequency of usage of a sentence structure, or some combination of these factors.

Mehler (1963) has reported that sentences of the type The man hit the boy--simple, active, affirmative, declarative sentences--are recalled better than sentences that contain transformations such as the negative and the passive. Furthermore, Mehler hypothesized, on the basis of an analysis of errors, that "... Ss analyze the sentences into a semantic component plus syntactic corrections when they learn them...." In a study by Martin and Roberts (1966), however, in which sentences varying in transformational history (sentence type) were equated on length and on a measure of sentence complexity (mean depth) developed by Yngve (1960), there was no evidence to indicate that simple declarative sentences are recalled better than sentences that contain one or more transformations. Sentence type did contribute to recall performance but in a nonsystematic fashion. In addition, for two-thirds of the sentence types used by Martin and Roberts, recall of structurally complex sentences was inferior to recall of structurally less complex sentences. Martin and Roberts went on to show, furthermore, that Mehler's results could be accounted for in terms of the depth measure.

A difficulty arises in the interpretation of the results of these two studies with respect to sentence type in that in both instances, this variable was treated as a within-Ss factor, i.e., each S was exposed to a list that contained sentences of all types. Under such circumstances, it is impossible to attribute the significant effect of sentence type to differences in learning ease, since it is also possible that a selection strategy was responsible for the significance. For example, Ss may have chosen to exert more effort in trying to memorize one type of sentence as opposed to another.

What appears to be needed is a study in which each sentence type is administered to a different group of Ss. Under such circumstances, i.e., when the syntactic information carried by each sentence within a list is identical, sentence type, as a measure of syntactic complexity, may contribute minimally to recall performance, even though syntactic complexity may vary from list to list. For example, in learning a list of eight sentences of the form The man hit the boy, the S has to store eight chunks of semantic information, but only one chunk of syntactic information.

The present study was designed to determine whether any differences exist in the ease of learning sentences of the type The man hit the boy (Type I), The boy was hit by the man (Type II), and It was the boy the man hit (Type III), using a homogeneous-list, independent-groups design and an immediate written recall task. It was anticipated, from the foregoing discussion, that the order of difficulty in recall performance would be, from least to most difficult, Type I, Type II, Type III, but that the effect would be minimal.

Method

Subjects. The Ss were 60 undergraduate paid volunteers who were assigned in rotation to 3 groups of 20 subjects each. The Ss were tested in groups of 6 to 10.

Material. Ten Type I sentences with low inter-item associative dependencies between the subject, the main verb and the object (Rosenberg & Koen, 1968) were prepared. The majority of the content words were rated as AA or A in the Thorndike and Lorge (1944) norms. All of the sentences contained an animate subject and an animate object. For half the Ss in each group, one noun in each sentence was used as the subject and the other as the object. This was reversed for the remainder of each group. Type II and Type III sentences were constructed from the same semantic content as Type I sentences. Five different orders of the sentences of each type were prepared to control for possible serial effects.

The stimulus materials were printed in booklets, one sentence to a page. Each booklet contained two repetitions of a list of sentences of a single type, separated by a filler sheet, and a blank lined card for use during the recall task. Five different arrangements of the five list orders were prepared for the two repetitions of each list.

Procedure. The Ss were tested in a research classroom. In each session, the booklets for the various conditions were distributed to the Ss in rotation after they seated themselves. All instructions were administered prior to presentation of the materials. The Ss were told to try to learn verbatim as many of the sentences as they could without regard for order within the list. For the recall task, they were instructed to write down, in the order in which they came to them, as many of the sentences as they could remember and to guess at words they were not sure of in cases in which they could recall only part of a sentence. All Ss received detailed instructions in the use of the booklets. The signals to turn the pages and the signal to begin the recall task were delivered orally by the experimenter. A metronome was used to time the exposure intervals, but the recall task was not timed.

Each sentence was exposed for 6 sec., the interval between each presentation of a list was 6 sec., and the interval between the end of learning and the beginnings of recall was 6 sec.

Results

Table 1 contains the means and SD's for verbatim recall of sentences and for total number of content words (nouns and main verbs) recalled correctly without regard for location on the recall sheet. The latter is a measure of the absolute recall of content items. The means for sentence recall are virtually identical, and an analysis of variance revealed $F\ (2,57) = .28$, $p > .25$. Clearly, sentence type did not contribute to sentence recall in the present study. Groups I and II recalled more content words than Group III, but here again, the effect of sentence type was not significant; $F\ (2,57) = 1.49$, $p > .10$. A breakdown of the content-word recall data into recall of subjects, main verbs, and objects, separately reveals results similar to the results for total content-word recall for each of these classes of items.

Insert Table 1 about here

Table 2 contains error-frequency data for various types of errors. Type A errors are correct-sentence recalls with the exception of reversal of subject and object. Type A errors, therefore, can be designated as semantic errors. Such errors occurred with very low frequency in Groups II and III, and not at all in Group I. A recalled sentence that contained the presented content words in correct subject-main verb-object relationship but which contained some change in

Insert Table 2 about here

syntactic structure is tabulated as a Type B error. These syntactic errors also occurred with very low frequency. Thus, it appears that if an S recalls all of the content words of a sentence, the probability that they will be recalled in correct subject-main verb-object relationship in correct syntactic context is high for all the sentence types used in the present study.

Type C errors are syntactically correct, sentence recalls that contain intra-list content-word substitutions (e.g., the object of one sentence might be recalled in the context of the subject and main verb of another sentence). While the experimental groups differed only slightly in the frequency of Type C errors, Type C errors (intra-list semantic errors) occurred with considerably greater frequency than Type A errors (intra-sentence semantic errors) in all three experimental groups. These intra-list semantic errors were most likely made possible by the weak associative constraints that exist between the content words within the sentences used in the present study.

All other complete-sentence recalls that could not be scored as correct are tabulated as Type D errors. This category included, for example, sentences that contained both syntactic and semantic errors. Type E errors are sentence fragments, and Type F errors are omissions. Type E and Type F errors appear to have occurred with greater frequency than other types of errors in all three groups. However, there is no consistent pattern of differences between groups for these two error types.

In general, then, while there are some interesting overall differences between error types, there is no particular pattern of errors that characterizes any of the experimental groups.

Discussion

Within the limitations of the design and the materials of the present study, it is clear that when an S has only a single type of syntactic information to store in learning a list of sentences, amount or complexity of syntactic information within a sentence (as herein defined) does not contribute to recall. From these results, one would predict that the mean depths (Martin & Roberts, 1966; Yngve, 1960) of the various sentence types used in the present study do not differ, because in Martin and Roberts' study, where depth was found to predict recall performance for a majority of the sentence types used, the depth variable was a between-Ss variable, i.e., lists were homogeneous with respect to this measure of syntactic complexity. However, for the Type I, Type II and Type III sentences, respectively, mean depth was estimated to be 1.00, 1.14 and 1.43. What is interesting here is that the range (.43) for these figures is as large as the range (.42) for the high- and low-mean depth sentences used by Martin and Roberts. The present study differed in a number of respects from the study by Martin and Roberts, but it is obvious that there are some limitations on the ability to predict recall performance on the basis of the linguistic-depth measure of syntactic complexity.

The next step in the experimental analysis of the problem of syntactic complexity as it relates to learning-ease, should be to give Ss a task in which they are required to process only one type of sentence at a time, but under conditions in which it will be difficult to establish a set for a particular sentence type. A short-term memory task in which Ss are exposed to, and have to recall, only one sentence type at a time from a series that contains sentences of various types arranged randomly, would appear to be best suited for this purpose.

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Footnote

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Table 1

Means and Standard Deviations for Sentence Recall and Content-Word Recall

	Measure			
	Sentences		Words	
Group	Mean	SD	Mean	SD
I	4.95	2.01	20.55	3.83
II	4.75	2.17	21.10	4.21
III	4.45	2.19	18.85	4.79

Table 2

Error Frequency Data

Group	Error Type						Total
	A	B	C	D	E	F	
I	0	1	24	7	26	43	101
II	1	2	22	9	34	37	105
III	3	0	16	12	31	53	115
Total	4	3	62	28	91	133	